Automated Public Lighting

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***Abstract*—Automated public lighting systems play an important role in energy consumption reduction. The advancement in wireless networks, control systems, sensors, embedded systems, and IoTs made it possible to design automated public lighting systems with smart technologies, where crucial issues like energy savings and cost reduction can be efficiently dealt with. The proposed system is focused on automated public lighting infrastructure.Here, the main idea is to maintain the lamps' brightness at their minimum allowable level in a certain segment of the street that is compatible with national/regional standards and/or safety limits for both vehicular and pedestrian traffic.**

***Index Terms*—Automated Public Lighting, Wireless Smart Poles, LDR and Lidar Sensors, Internet of Things, IEEE 802.15.4, Zigbee Communication, Energy Saving, Low cost monitoring system.**

I. Introduction

Improving automated public lighting involves optimizing its efficiency, cost-effectiveness, and environmental impact. Here are some steps to achieve this:

- LED Conversion: Replace traditional lighting with energy-efficient LED lights. LEDs consume less energy and have a longer lifespan, reducing maintenance costs.
- Smart Lighting Controls: Implement smart lighting systems that use sensors and timers to adjust light levels based on ambient conditions, such as daylight, pedestrian or vehicle presence, and time of day.
- Remote Monitoring: Install a remote monitoring system to track the performance of public lighting in real-time. This allows for quick response to faults and reduces downtime.
- Energy Management: Use energy management software to analyze and optimize energy consumption, identifying areas for further efficiency improvements.
- Dimming and Zoning: Implement dimming and zoning capabilities to reduce light intensity during off-peak hours or in areas with low activity.
- Motion Sensors: Install motion sensors in less frequented areas to activate lights only when needed, saving energy and reducing light pollution.
- Solar and Renewable Energy: Consider integrating solar panels or other renewable energy sources to power streetlights, reducing electricity costs and environmental impact.
- Data Analytics: Use data analytics to predict maintenance needs and plan proactive repairs, reducing operational costs and increasing reliability.
- Light Pollution Reduction: Use shields or fixtures designed to minimize light spill and glare, reducing light pollution and preserving the night sky.

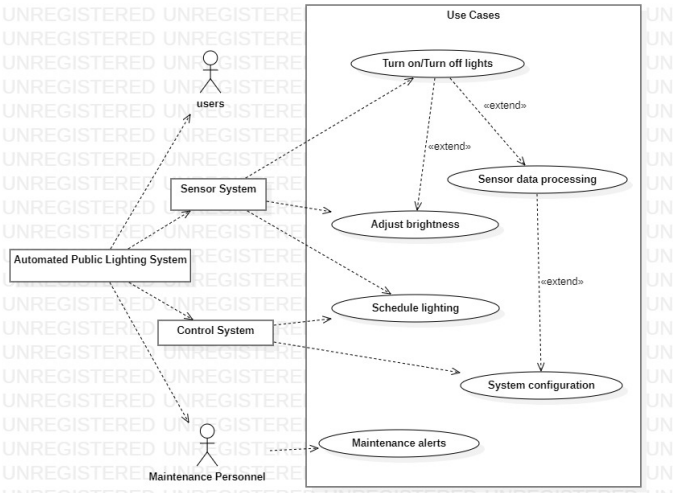

Fig. 1. Use Case Diagram

- Public Engagement: Involve the community in decisions regarding lighting improvements to ensure that the lighting meets their needs and concerns.
- Budget Planning: Develop a long-term budget plan for maintaining and upgrading public lighting infrastructure to ensure sustainability and efficiency.
- Compliance with Standards: Ensure that the lighting system complies with local regulations and standards, including safety and energy efficiency requirements.

II. Automated Public Lighting Architecture

The proposed system is focused on Wireless smart poles which is a street lighting lamp composed of LED bulbs, LDR and LiDAR sensors, weather sensors, communication devices and highly efficient LED lamps. The smart poles can exchange data (control commands and information requests) among them and, through a gateway, with a remote management web application. The overall cost of the investment in this type of smart lighting technology is low. The system is also capable of achieving good traffic monitoring performance. Here are some unique characteristics of proposed system (smart poles) -

- Remote management of public lighting system.
- Monitoring of street lighting lamps.
- Controlling light intensity.
- Analysing of Energy consumption and evaluation.
- Capable of dimming and zoning.
- Dynamic network topology.

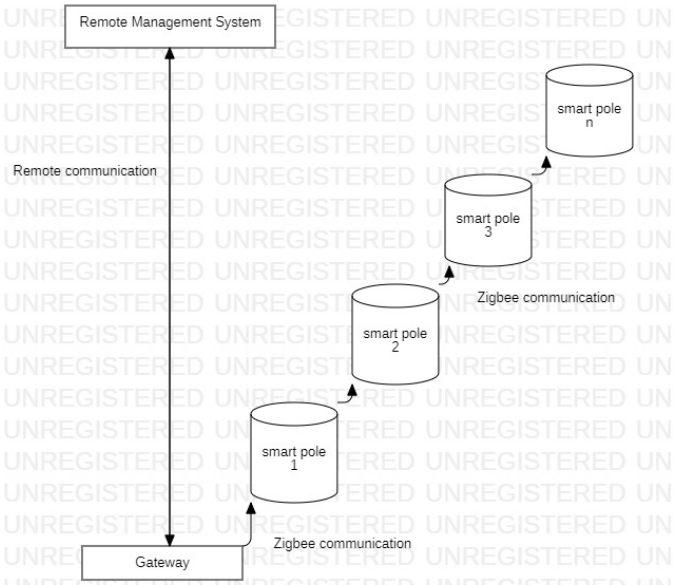

Fig. 2. Block Diagram of System

- Pollution monitoring and climate control.

III. Method or Technology

- Wireless smart poles.
- Local communication devices based on IEEE 802.15.4.
- Zigbee communication protocol.
- Remote management station.
- Remote communication based on 3G/4G/Wi-Fi communication.
- LDR and LiDAR sensors, Raspberry Pi.
- Lighting control system.

IV. Analysis

- Smart Lighting Control:LDRs can detect ambient light levels, allowing the smart pole to automatically adjust the intensity of street lighting based on real-time conditions. LiDAR sensors can further refine this by detecting the presence of pedestrians, vehicles, or cyclists, illuminating areas only when needed for added energy efficiency and safety.
- Pedestrian Safety:LiDAR sensors can identify pedestrians at crosswalks, and when coupled with LDR data, they can activate warning signals or pedestrian-activated crosswalk lights when ambient light is low, enhancing pedestrian safety.
- Security and Surveillance:LDRs can trigger LiDAR-enabled security cameras when lighting conditions change unexpectedly, helping to capture clear images and video footage during low-light situations for improved security.
- Navigation Assistance for the Visually Impaired:Smart poles equipped with LiDAR sensors can aid the visually impaired by detecting obstacles in their path and providing audio or tactile feedback for safer navigation.

V. Conclusions

In conclusion, smart public lighting represents a significant advancement in urban infrastructure that offers a multitude of benefits to communities and cities. By integrating cutting-edge technology into traditional street lighting systems, smart public lighting provides enhanced functionality, improved efficiency, and a better quality of life for residents. Smart public lighting not only illuminates our streets but also illuminates the path toward more sustainable, connected, and safer cities. As technology continues to advance, the potential benefits of these systems will likely expand, further improving the quality of life for urban residents and contributing to the overall well-being of communities.

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